Stereotaxic Needle Localization and Cytological Diagnosis of Occult Breast Lesions

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A stereotaxic technique for localization of occult breast lesions and fine needle aspiration for cytological diagnosis was used on examination of 543 patients. Successful localization with the needle tip within 1 mm of the suspected lesion was possible in 490 patients (90.2%). Based on a high mammographic index of suspicion for malignancy, 187 of 490 patients were selected to undergo open biopsy, following aspiration cytology and localization with methylene blue injection. The statistical results (cytologic *vs.* histologic examination) revealed a sensitivity of 97.5% and a specificity of 95.2% for cytologic diagnosis of occult breast lesions. The technique is easy to learn and takes 20–30 minutes to perform. Compliance was 100% and complications were nil. This new technique expedites localization and maximizes the specificity of mammography for occult breast lesions.

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THE PROGNOSIS OF BREAST CANCER is significantly influenced by the size of the tumor and the presence and the number of positive axillary lymph nodes. Until recently, 90% of breast cancers were discovered by women themselves. Consequently, even in large cancer centers, the proportion of T1 tumors (less than 2 cm in diameter) was only 15%.[1] Since 1971, in the Federal Republic of Germany, all women above age 30 have had access to an annual free cancer check-up. Since that act, the proportion of T1 breast cancers recorded at the Department of Gynecology and Obstetrics at the University of Kiel has risen to 40%.

When such small tumors are deeply placed in the breast, their detection can be achieved only by mammography.[2] In the recent literature, Holland et al.,[3] among others, have pointed out the particular significance of microcalcifications appearing in preliminary mammographs of women with no clinical symptoms. Needle localization of these occult tumors under mammographic control, prior to open biopsy, takes up to 1 hour of a radiologist's time, and often the lesion is located only approximately. Patients are then transferred to an operation room where, under local or general anesthesia, an open biopsy of the suspected lesion is performed. Only 10–20%[4] of such biopsies are cancerous. Thus, the majority of mammographically detected shadows with the present technique are histologically benign.

In order to improve the accuracy of localization, as well as to maximize the preoperative information of these occult breast lesions, a stereotaxic technique was developed by Bolmgren et al.[5] in 1977, and later evaluated by Nordenstrom[6] and Svane[7] at Karolinska Institute, Stockholm, Sweden. In this report, we present our 3-year experience with this new technique at the University of Kiel.

Equipment

The new equipment for stereotaxic needle biopsy (Fig. 1) includes a tabletop, mounted on a vertical steel column and set in a heavy floor support. The column height may be adjusted by remote control, thus allowing coordinate movements of the tabletop, which also contains an aperture for the breast. Two compression plates are mounted on a console below the table. The posterior plate is firmly fixed to a support and is provided with an engraved radiopaque millimeter scale corresponding to a 50 × 50-mm window in the movable anterior compression plate. Below this, the x-ray tube is mounted on a hinged arm. The compression device, the stereotaxic instrument, and the hinged arm with the x-ray tube are movable by remote control in a verticle direction against the console, which itself is movable 180 degrees on a horizontal plane.

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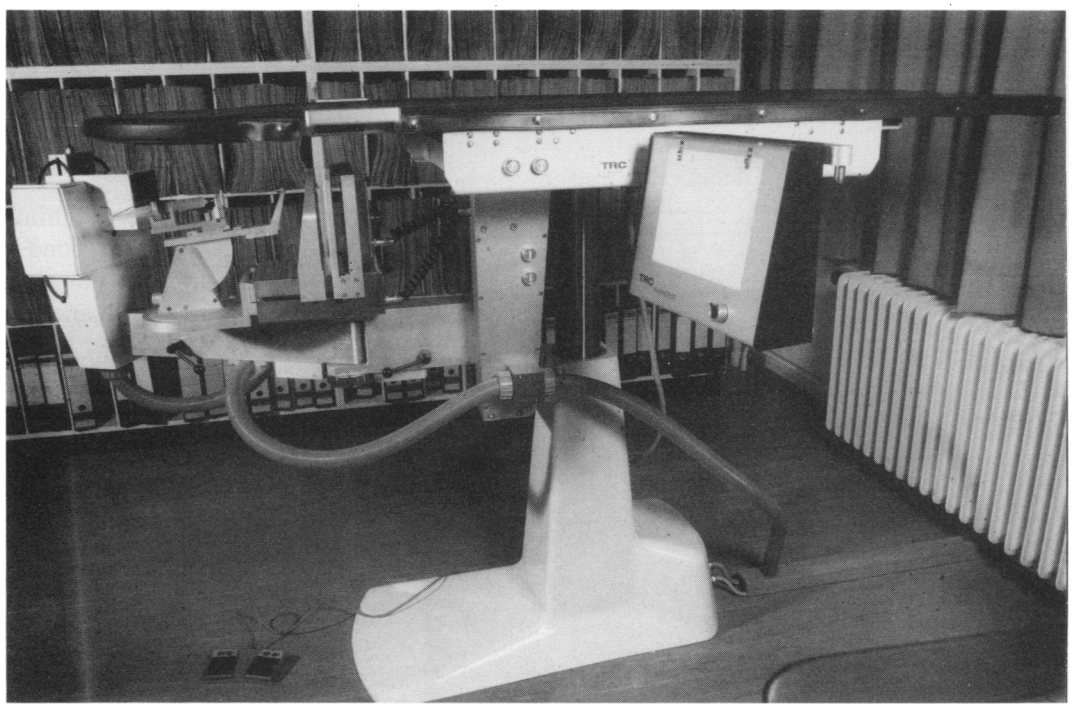


FIG. 1. TRC Mammotest device (Taby, Sweden) with its console and a table top on which the patient lies. The x-ray tube (left side) is attached to a hinged arm in front of the puncture device and the film holder.

The mechanical versatility of the equipment allows radiography and biopsy of the breast in any of the projections used in mammography. Independent of the projections, the x-ray tube can be angulated at ±15 degrees in relation to the compression device, which carries the film cassette in a holder behind the posterior compression plate.

Biopsy Instrument

A double cannula needle (outer diameter 0.7 mm, inner diameter 0.5 mm, length 150 mm) and a 20-cc disposable syringe, with a special spring lock to maintain the vacuum after insertion, were used in this series (Figs. 2A & B).

Technique

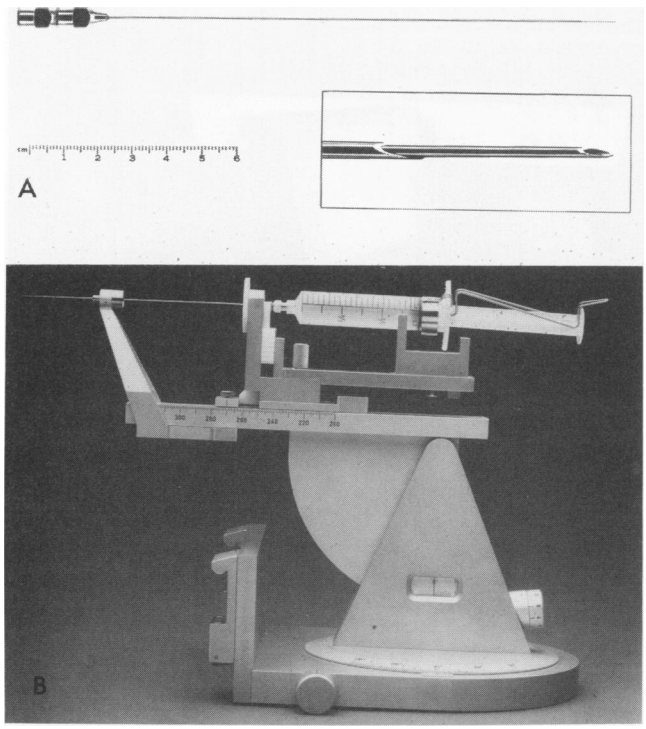
In preparation for a biopsy of a nonpalpable breast lesion, the mammographic view was chosen so that the distance to be traversed by the biopsy needle was as short as possible. The patient lay on the examination table in a prone position with the breast hanging down through the aperture.

The distance between the nipple and the lesion was measured from the selected mammographic view. The breast was placed between the compression plates, and the lesion was positioned within the window in the anterior plate. The breast was then fixed in this position and the patient was requested not to move during the examination, which usually lasts 15–20 minutes. Two mammographic views of the breast at 30 degrees to each other were taken, and the coordinates for the center of the lesion were read on the exposed film. These Cartesian coordinate values were transferred into a small analogue computer that translates them into three polar coordinates. All measurements were made from the estimated center of the lesion. The stereotaxic instrument was fixed in a predetermined position in front of the compression plates. The puncture site of the breast was sterilized. After mounting the needle onto its holder, the needle was pushed into the breast according to the precalculated distance and angle. The position of the cannula was checked by means of two stereoradiographs (Fig. 3). With experience, it was possible to place the tip of the needle within ±1 mm of the periphery of the suspected lesion. At this point, the inner cannula of the needle was removed and aspiration of the cellular material was performed by means of a 20-cc syringe, employing hand suction with a special spring lock attached to the syringe plunger.

The aspirate was smeared on glass slide, fixed in alcohol, stained with hematoxylin and eosin, and was interpreted on the same day. The breast lesion was then marked by 1.0–2.0 ml of methylene blue injection through the needle. Patients underwent open breast biopsy of the localized area, and the tissue sample was independently reported by a pathologist.

Results

The cytologic reports were classified according to four diagnostic categories: (1) tumor cells; (2) suspicious for



FIGS. 2A and B. *A.* Double cannula needle (gauge: 21 length: 15 cm) for localization and cytologic sampling of occult breast lesions. *B.* Needle holder with inserted double cannula and 20-cc syringe.

tumor: atypical nuclear or cytoplasmic appearance, but not definite criteria of malignancy; (3) benign, and (4) insufficient material: too few interpretable cells.

Since it was certain that in every case the needle had been located in the lesion, for statistical evaluation, the categories (1) and (2) of above were grouped together; likewise for (3) and (4).

Between 1983 and 1985, 543 patients with mammographically detected suspicious breast lesions were referred to the center. The procedure could not be performed on 53 patients (9.8%) for various reasons, as shown in Table 1. The remaining 490 patients were divided into three groups (see Table 2) of low, intermediate, and high degree of suspicion, according to the mammographic report. Patients in all three groups underwent aspiration cytology of the suspicious shadows. Only those patients in group 3 whose preliminary mammogram was suggestive of malignancy were referred for surgery and tissue biopsy.

Group 1 (Low Suspicion of Malignancy)

Of 148 patients, the cytologic examination of lesions revealed no evidence of malignancy. These patients have been followed up for a period of 9–30 months by interval mammography, and so far no case of cancer has been observed.

Group 2 (Intermediate Suspicion of Malignancy)

Of the 155 (31.6%) patients in this group, cytologic examination was negative for malignancy. However, because of the higher index of suspicion for cancer, all of these patients underwent a repeat needle localization and cytologic aspiration of the suspected lesion within 6–12 months after the initial examination. Benignity was confirmed in all cases at the second examination. Subsequent surveillance—up to 24 months—by mammography has not revealed any breast cancer.

Group 3 (High Suspicion of Malignancy)

The focus of this report is on this group, which consisted of 187 women whose cytologic examination was followed by dye-localization and open biopsy of the suspected lesion. In 31 of 187 patients (16.6%)—see Table 3—the cytologic aspiration contained insufficient material and histological diagnosis was reported to be benign. In 13 of 31 patients, the histology was fibrocystic disease. In 14 patients, what had appeared at mammography to be a round shadow histologically was proven to be one of the following: fibroadenoma, adenosis, lobular hyperplasia,

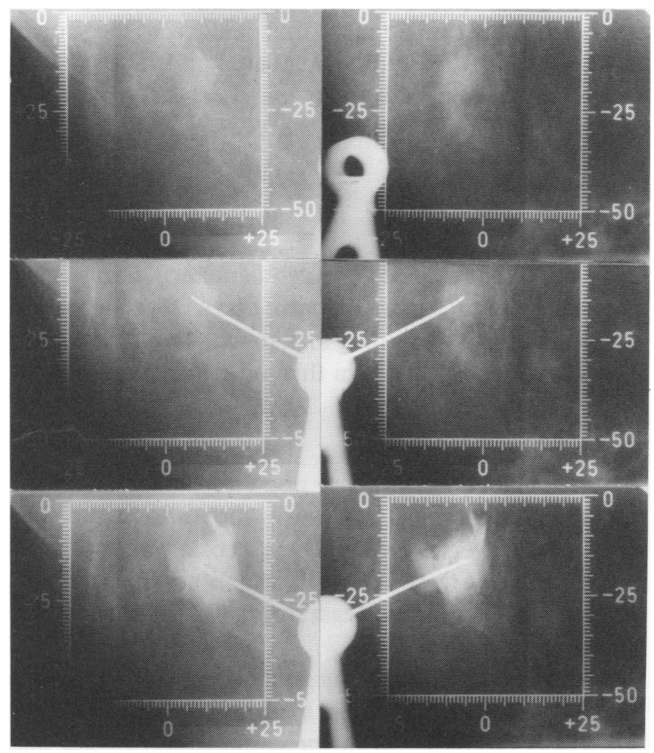


FIG. 3. The different steps involved in localization and sampling. *Top.* The breast is positioned so that the suspected lesion is seen within the compression plate window. *Middle.* Control radiograph to confirm the position of the needle tip before sampling is commenced. *Bottom.* Appearance of the lesion after its localization with methylene blue and prior to open biopsy.

TABLE 1. *List of Technical Failures*

Reason for Failure	Number of Patients	% of 543
Lesion too close to chest wall or micromastia	14	2.6
Nonvisualization of the lesion due to summation effect or interval resolution	14	2.6
Nonpenetration of the lesion and needle deviation > 1 mm	25	4.6
Total	53	9.8

TABLE 2. *Three Groups According to Mammographic Index of Suspicion for Malignancy*

		No. of Patients	Per Cent
Group 1	Low index of suspicion for cancer	148	30.2
Group 2	Intermediate index for suspicion for cancer	155	31.6
Group 3	High index of suspicion for cancer	187	38.2

chronic mastitis, or adiponecrosis (oil cyst). In the remaining four patients, histologic diagnosis was fibrosis.

In 110 of 187 patients (58.8%), cytology revealed a benign lesion. The histologic diagnosis in 109 patients was in agreement with cytology. However, in one patient the histology showed a lobular carcinoma *in situ.* The original mammogram and stereodiagraphs did not identify the true diagnosis of this lesion.

In 12 of 187 patients (6.4%), the cytologic evaluation showed suspicious tumor cells. In five patients, the histology confirmed malignancy. In the other seven patients, histologic diagnosis was either proliferating mastopathy with atypia or papillomatosis with atypia. In other words, in all patients morphologic changes were found that needed further clarification.

In the remaining 34 of 187 patients (18.2%), open biopsy corroborated with the cytologic diagnosis of malignancy in every case.

Considering the open tissue biopsy as gold standard, 147 lesions (78.6%) of our patients showed benign histology. The remaining 40 patients (21.4%) had lesions that were proven to be malignant. Histologic details and the size of these tumors are as follows: 20 lesions were smaller than 5 mm (8 ductal carcinoma *in situ,* 2 lobular carcinoma *in situ,* 10 invasive ductal cancers); ten lesions were between 6 and 10 mm (2 intraductal, 1 lobular carcinoma *in situ,* 7 invasive ductal cancers); and ten tumors were between 11 and 20 mm (1 intraductal, 8 invasive ductal cancers, 1 medullary cancer). The statistical evaluation of the results, according to the "Vier–Felder Test" (chi square), revealed a sensitivity of 97.5% with a false-negative rate of 2.5%, and a specificity of 95.2% with a false-positive rate of 4.8% and a diagnostic efficiency of 95.7% (see Table 4).

Discussion

Improvement in survival and cure of patients with breast cancer through mass screening and early detection is the goal of much effort. Modern mammography, with low-dose radiation and a high degree of image resolution, has come to play the primary role in the screening of asymptomatic women. The sensitivity of this diagnostic modality in visualizing clustered calcifications and abnormal soft tissue shadows is high, but the specificity remains low. Only 20% of microcalicifications and 14% of suspicious shadows on subsequent open biopsies are shown to be malignant.[4] The ratio of malignant to nonmalignant biopsies increased with age from 1:16.4 among the 35–39-year-old group, to 1:3.2 in the 65–69-year-old group, as reported in the Breast Cancer Detection and Demonstration Project.[8]

Precise localization of these small and nonpalable tumors also poses a problem because the breast does not have a fixed shape or a reliable constant landmark except for the nipple. Therefore, surface marking of the breast in a compressed state during mammography is of little value when the patient is in supine position on the operating table. Invasive techniques involving preoperative insertion of needles, wire, and carbon[9–11] under x-ray control are currently practiced according to the preference of the individual radiologist and surgeon. Generally, the

TABLE 3. *Comparison Between the Cytologic Evaluation and the Histologic Diagnosis in 187 Patients*

	Cytologic Evaluation		Histologic Diagnosis		
	N	Per Cent	Benign	Noninvasive Cancer	Invasive Cancer
Insufficient material	31	16.6	31	—	—
No tumor cells	110	58.8	109	1	—
Suspected tumor cells	12	6.4	7	3	2
Tumor cells	34	18.2	—	9	25
Total	187	100.0	147 (78.6%)	13 (7.0%)	27 (14.4%)

TABLE 4. *Validity of Stereotaxic Fine Needle Biopsy*

	Histology		
	Malignant	Benign	Total
Cytology positive for cancer	True-positive N = 39	False-positive N = 7	Test-positive N = 46
Cytology negative for cancer	False-negative N = 1	True-negative N = 140	Test-negative N = 141
Total	N = 40	N = 147	N = 187

less accurate the localization, the higher the risk of not finding the lesion, the more extensive the surgery, and the greater the breast disfigurement will be. Removal of nonpalpable breast lumps without preoperative marking is not free of risk. In a series of 1009 such patients,[12] postbiopsy mammogram revealed that 10.1% of the lesions had not been removed, and 1.1% of these tumors on subsequent biopsies were proven to be cancerous.

Stereotaxic needle localization of impalpable breast lesions appears to have overcome these two problems. First, it pinpoints the lesion with an accuracy of ±1 mm, as measured on postinsertion control radiographs in 95.4% of the patients in this series. If we analyze the failure rate of 9.8%, as depicted on Table 1, it becomes evident that, in 14 patients, the lesion was too close to the chest wall, or the breast was too small to be held in the compression unit—an inherent technical defect of every localizing system. In 14 additional patients, the breast lesion, shown on the initial mammogram, could not be revisualized; therefore, biopsy was not attempted. Possible explanations are summation effect or interval resolution of the lesion, such as a cyst, or inflammation. The failure rate of precise localization with this system occurred in 25 of 543 patients (4.6%) where the needle tip deviated more than 1 mm due to nonpenetration of the lesion. The small failure rate is attributed to some densely capsulated tumors, such as fibroadenoma, causing nonengagement and needle tip deviation.

Secondly, fine needle cytology through stereotaxic localization increases the specificity of mammography to 95.2%, as reported in our series. This additional procedure takes little extra time. The sampling maneuver caused minimal patient discomfort and no complication in our series. The cytologic information, considered in conjunction with the clinical as well as the mammographic data, will enable the clinician to decide on a policy of: (1) open biopsy, (2) repeat cytology 3–6 months later, or (3) wait and see by interval mammography. Such a policy results in operating on women with a high or intermediate index of suspicion for malignancy only. On the basis of such a policy, we missed one breast cancer in 187 patients. If we consider the entire 490 patients examined by the stereotaxic localization technique and needle aspiration cytology, who would have otherwise undergone open biopsy for diagnosis of occult breast lesions, the benefit of this new technique becomes even more apparent. Svane et al.[13] reported on 120 nonpalpable breast lesions stereotaxically localized. Needle cytology assessment was correct in 80% of 62 histologically proven cancers. However, when the combined reports of lesions mammographically and cytologically suspicious for cancer were considered, correct diagnosis was made in 61 of 62 histologically malignant tumors. There was no false-positive cytologic result. It cannot be overemphasized that close surveillance of these mammographically appearing benign lesions with regular follow-up is mandatory.

In conclusion and in agreement with Swedish investigators, we believe that the stereotaxic needle localization technique is a significant advance in terms of accuracy, expediency, and manpower efficiency in detecting impalpable breast lesions. Needle aspiration cytology performed in conjuction with such a precise technique appreciably raises the specificity of mammography, which is currently low.

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References

1. Fisher B, Slack N, Bross, IDJ, et al. Cancer of the breast: size of neoplasm and prognosis. Cancer 1969; 24:1071–1080.
2. Egan RL, Goldstein GT, McSweeny, MM. Conventional mammography, physical examination, thermography and exeroradiography in the detection of breast cancer. Cancer 1977; 39: 1984–1992.
3. Holland R, Hendricks JHCL, Mravumak M. Mammographically occult breast cancer. Cancer 1983; 52:1810–1819.
4. Moskowitz M. Minimal breast cancer, redux. Radiol Clin North Am 1983; 21:93–113.
5. Bolmgren J, Jacobson B, Nordenstrom R. Stereotaxic instrument for needle biopsy of the mammary. Am J Roentgenol 1977; 129: 121–125.
6. Nordenstrom B, Azjicek J. Stereotaxic needle biopsy and preoperative indication of non-palpable mammary lesions. Acta Cytol 1977; 21:350–351.
7. Svane G. Stereotaxic needle biopsy of non-palpable breast lesions. A clinical and radiological follow-up. Acta Radiol Diagn 1983; 24:385–390.
8. Baker LH. Breast cancer detection and demonstration project: five-year summary report. Cancer 1982; 32:226–230.
9. Libshitz H, Feig S, Fetouh S. Needle localization of non-palpable breast lesions. Radiology 1976; 121:557–560.
10. Kopans D, De Luca S. A modified needle–hookwire technique to simplify preoperative localization of occult breast lesions. Radiology 1980; 134:781.
11. Svane G. A stereotaxic technique for preoperative marking on nonpalpable breast lesions. Acta Radiol Diagn 1983; 24:145–151.
12. Ulrich A. Grenzen und Moglichkeiten der gezielten praoperativen Lokalisationsdisgnostik bei mamographisch suspekten Befunden—insbesondere beim klinisch okkulten Mammakarzinom. Dissertation, University of Gottingen, 1983.
13. Svane G, Silfversward C. Stereotaxic needle biopsy of non-palpable breast lesions. Cytologic and histopathologic findings. Acta Radiol Diagn 1983; 24:283–288.